# Wide-Scale Use of Miniature Robotic Aircraft to Improve Weather Forecasts Up to 14 Days

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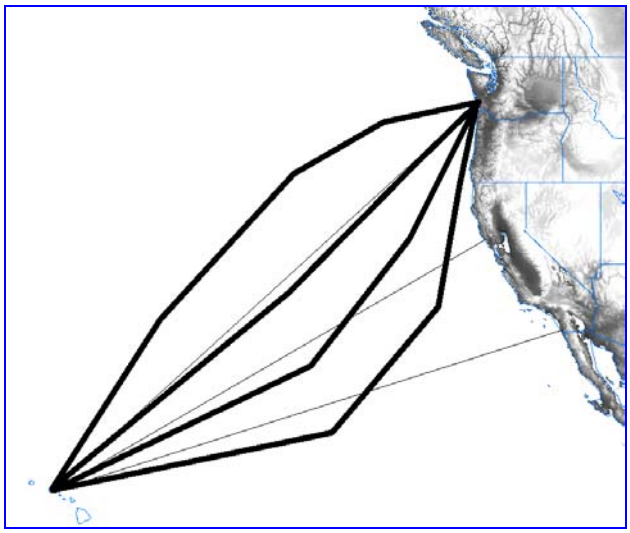
We suggest an initiative by NASA, jointly with NOAA and its counterparts abroad, economically to fill chronic voids in upper-air data over oceans and remote areas. This would be part of NASA's ongoing participation in the international THORPEX program, which aims to improve global weather forecasts through more effective gathering and assimilation of atmospheric data. THORPEX is in turn a component of the International Polar Year and the US Weather Research Program. Our suggested initiative involves two of NASA's Focus Areas: (1) Exploration of the Dynamic Earth System, and (2) Advanced Aeronautical Technology.

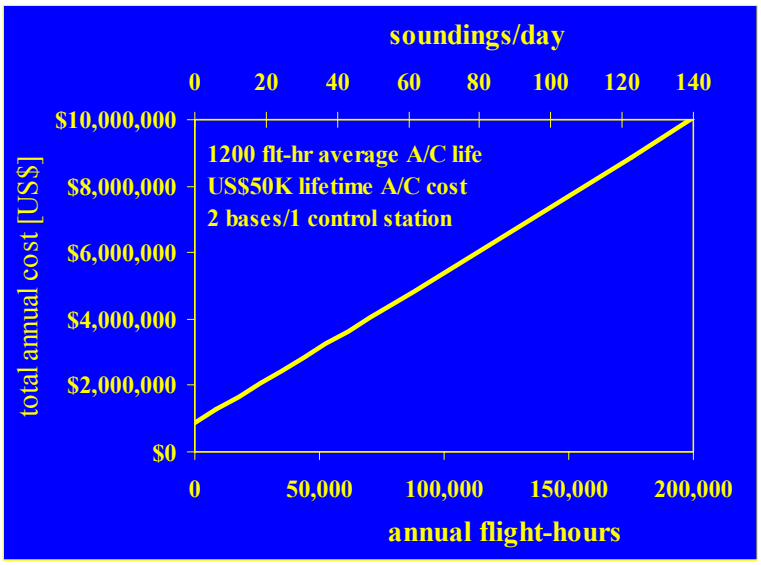


Voids in upper-air data over the Pacific could be filled economically by a fleet of tabletop-sized robotic aircraft circulating daily between Hawaii and the west coast.

Numerical weather-forecasting models, however powerful, are only as good as the observational data used to initialize them. A key objective of THORPEX is to determine whether 1-to-14-day forecasts of high-impact events can be significantly improved by adding upper-air observations in data-sparse areas, notably over the oceans. Historically, such observations have called for large dropwindsonde-launching aircraft, or balloon-launching ships. These are much too expensive for use except in short research campaigns. However miniature sounding aircraft offer a revolutionary solution, with the range and flexibility to be targeted into sensitive areas far from land bases, and the economy to allow routine wide-scale use. This concept was proposed in the 1990s. Testbed aircraft made the first unmanned transatlantic flight (1998), first unmanned typhoon reconnaissance (2001), and pioneering trials with the weather services of Australia, Canada, Taiwan, Japan, Korea, and the US, in conditions ranging from the arctic to severe tropical thunderstorms. New aircraft now in production, such as The Insitu Group Seascan, can quickly be deployed in this role, and technical development could lead to substantially more capable aircraft being available in later years.

Hence we envision programs of operations and technology development. The operations component would involve routine reconnaissance of the NE Pacific (or possibly the Arctic)

using current-production aircraft. They would operate from bases on the west coast or Hawaii on missions spanning thousands of kilometers and about 2 days duration, targeting areas of high data value as they varied from day to day. Each aircraft would make 6-8 soundings per day from the surface to above 20,000 ft, or cruise in specific altitude bands as appropriate to the weather situation. Data would be returned via Iridium satcom link in near-real-time, and their forecast impact evaluated using THORPEX protocols. The cost would be a few million dollars per year to maintain about 10 aircraft in the air at any one time. Such an operation would provide a volume of offshore upper-air data comparable to that from the whole US radiosonde-balloon program, dramatically filling a huge void with new *in situ* data, and providing ground truth to make satellite observations more effective. If global forecasting skill improved substantially as expected, then the program could be taken over and expanded by NOAA (and its counterparts abroad) as an ongoing operation.




An operational program costing a few million dollars per year would generate an unprecedented volume of high-quality upper-air data offshore, for example covering the whole northern Pacific at a density comparable to that of radiosonde soundings over the continental US.

Parallel technology development would improve miniature-aircraft performance and instrumentation. Particular areas for attention include the following:

- Range and endurance of aerosonde-size aircraft could be roughly doubled (to around 8000 km/4 days) by a small-displacement engine (~1 kW) having power-to-weight and specific fuel consumption comparable to that of a typical automobile engine. No such engine is presently available.
- Measurement capability could be expanded beyond basic radiosonde sensors for pressure/temperature/humidity/wind. Examples include: (1) "BAT-type" momentum-flux system, including a 9-point nose-pressure set and strapdown INS/GPS; (2) Sea-surface radiometer; (3) GPS scatterometer; (4) Miniature LIDAR.

**Prospective benefits**

Miniature robotic aircraft offer an unprecedented opportunity to gather the data necessary for substantial improving weather forecasts on a wide scale. The benefits of such improvements are numerous, valuable, and extensively documented in the THORPEX plan and elsewhere.